AFMC LSO/LOP

5215 THURLOW ST
WRIGHT-PATTERSON AFB OH
45433-5540
FAX 937-656-1350

PACKAGING PERFORMANCE TESTING OF A 4-GALLON METAL DRUM, CONTAINING FOUR 1-QUART RECTANGULAR PLASTIC BOTTLES - PACKING GROUP II AND III (AIR AND SURFACE MODES)

AFPTEF PROJECT NUMBER: 00-P-101 JULY 2000
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/TR00012

Part 1. Report Cover
TEST REPORT APPLICABILITY STATEMENTS see section 2E:
Manhours: 20 Hours

Report Prepared by: _____
Susan Evans
Materials Engineer

A. Report Number: DODPOPHM/AF69/TR00012

B. Title:
4-GALLON METAL DRUM, CONTAINING FOUR 1-QUART RECTANGUALR PLASTIC BOTTLES WITHOUT HANDLES - PACKING GROUP II AND III (AIR AND SURFACE MODES)

Responsible Individual: Michael D. Werneke
This report has been approved for publication and dated:

L.A. WOOD, Chief Engineering Branch	MICHAEL WERNEKE Acting Chief, AF Packaging Technology and Engineering Facility

Performing Activity:
AF Packaging Technology and Engineering Facility
AFMC LSO/LOP
5215 Thurlow St
WPAFB OH 45433-5540

AFPTEF Reference: 00-P-101
Date: 27 July 2000
Report Type: **Final**

Specific Authority:
Distribution Statement F. Further dissemination only as directed by the Air Force Packaging Technology and Engineering Facility (AFPTEF), AFMC LSO/LOP, 5215 Thurlow St, WPAFB OH 45433 or higher DoD authority.

Requesting Organization: Defense Logistics Agency
DDC-TO
ATTN: Linda McCarthy
2001 Mission Drive
New Cumberland PA 17070

Requesting Organization's Reference(s):
(1) Memorandum, DDC-TO, 20 Sep 99.

Part 2. Data Sheet

A. Exterior Shipping Container

UN Type: Steel Drum, Open Head
UN Code: 1A2
Specification Number(s): MIL-D-6054, MS-27684-21, 4-gallon capacity
Container Manufacturer: PACKAGING SPECIALTIES, MEDINA OH 44256
Date of Manufacture: 2000
Material: Steel
Container Dimensions: 300 mm diameter x 368.3 mm high
Closure (Type/Method): LOCKING RING, NUT, BOLT RUBBER SEAL.
Closure Specification Number(s): MIL-D-6054F, Paragraph 30.1
Absorbent Material Description: Vermiculite, Fine Grain, PALMETTO Vermiculite Co.
Additional Description: N/R

B. Inner Packaging of Combination Packaging

Type: Rectangular plastic bottle, with funnel-spout.
Manufacturer/Distributor: Consolidated Plastics, Inc.
Date of Manufacture: N/R
Manufacturer's Number(s): 40622LG
Capacity: 1 quart
Dimensions: 4.38 in. x 2.0 in. x 8.75 in.
Closure (Method/Type): Cap and fiber-reinforced tape.
Additional Description:

C. Actual Product: Not Used

D. Test Product: Used

Name:
United Nations Packaging Group: II
Physical State: liquid
Amount per container: 4 quarts
Test Weight: 9 Kg (21 lbs)
Density/Specific Gravity: 1.0 (50% water/propylene glycol mixture)
Drop Height: 1.2 meters
Stacking Weight/Force: 70 Kg (156 lb)
Additional Description:

1. Line the drum with a 4 mil polyethylene bag, twist and tape closed.
2. Place 2 ½ in. of vermiculite absorbent in bottom of drum. Place 4 bottles on vermiculite. Add 2 in. vermiculite between bottles and sides of container, cover with vermiculite.
3. Shake down and add vermiculite to make a tight pack.
4. Closure IAW MIL-D-6054F, Paragraph 30.1.

E. Test Applicability- See test results in parts 7

(1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.

(2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.

(3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

(4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

(5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.

(6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.

(7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

(8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.

(9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT's or international's regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3 Introduction.

Brief description of why specific tests were performed and rational for the test product selected (if applicable).

The equivalent of Packing Group II testing, air eligible, was requested on the above stated configuration. This configuration is intended to be applicable to a large assortment of liquid products contained in plastic bottles. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g).

A 50% water/propylene glycol mixture was used as the test liquid as permitted by 49 CFR part 178.602(c) and the combination packaging was conditioned prior to the drop test for a minimum of 24 hours at 18°C.

Each combination packaging was subjected to the appropriate drop and vibration testing as prescribed by ASTM D4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was hydrostatic pressure testing (these samples not used in further testing), vibration test, stacking test, and finally the drop test.

The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was excercised in this test as noted in Part 7.

Part 4. Tests Required/Performed:

A. Hydrostatic Pressure Test - 3 containers each individually tested for 5 minutes at 15 psig.
B. Stacking test - One test per container, 3 containers required. Compression by a top load is calculated to simulate a stack height of **3 meters**, maintained for 24 hours, followed by testing the containers stability by placing two loaded containers on top of the tested container for at least 1 hour.

NOTE: Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

C. Drop test - 6 drops, requiring 6 sample containers. First drop (using 3 samples): The package must strike the target diagonally on the chime or, if the packaging has no chime, on a circumferential seam or an edge. Second drop (using the other 3 samples): The package must strike the target on the weakest part not tested by the first drop, for example a closure or for some cylindrical drums, the welded longitudinal seam of the drum body. The drop height shall be appropriate for the packaging group of the commodity (See part 6). The container shall strike the target which shall be a rigid, non-resilient, flat, and horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact.

Testing of plastic drums, jerricans, boxes (other than expanded polystyrene boxes), composite packagings (plastic material) and combination packagings with plastic inner packagings other than plastic bags intended to contain solids or articles, must be carried out when the temperature of the test sample and its contents has been reduced to -18°C or lower. Test liquids shall be kept in the liquid state, if necessary, by the addition of anti-freeze.

D. Vibration Test (Domestic requirement). One test per container, total of three test specimens.

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178.

MATERIAL SPECIFIC TEST

NONE

Part 5. Applicable Packing Group Test Requirements:

A. Hydrostatic Pressure Test
Three containers each individually tested for 5 minutes at 15 psig. No leakage is allowed.

B. Stacking Test.
Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m\,(3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms = 9 Kg
h = container's height in millimeters = 355.6 mm (effective height for container in stack)
M = constant load mass in kilograms = 156 Kg

or:
$$W = \frac{w\,(118-h)}{h}$$

where: w = container's gross weight (as shipped) in pounds = 21 lb
h = container's height in inches = 14.0 in. (effective height for container in stack)

W = constant load weight in pounds = 156 lb

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

C. Drop Test.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm^3 (specific gravity less than 1.2) the drop height shall be:

Packing Group	Drop Height
I	**1.8 m** (70.9 in.)
II	**1.2 m** (47.2 in.)
III	**0.8 m** (31.5 in.)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

Packing Group	Drop Height
I	**(d) x 1.5 m** ((d) x 59.1 in.)
II	**(d) x 1.0 m** ((d) x 39.4 in.)
III	**(d) x 0.67 m** ((d) x 26.4 in.)

Round the drop height up to the first decimal.

D. Vibration test.

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

Part 6. Criteria for Passing Tests:

A. Hydrostatic Pressure Test - Any leakage is cause for rejection.

B. Stacking test.

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety. When employing a dynamic compression tester, a container passes if after application of the required load for the specified time, there is no buckling of the sidewalls sufficient to cause damage to the contents; in no case shall the maximum deflection exceed **1** inch.

C. Drop test.

Each packaging containing liquids shall be leakproof when internal and external pressures are equalized.
Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak the filling substance or lading.

D. Vibration test.

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

Part 7. Discussion and Test results:

Narrative description of test results, including any rationale for variations. These test procedures meet the 49 CFR requirements. See Part 3 for detailed discussion of acceptable DoD deviations, which **were** exercised here. For the packaging to pass, all applicable tests must be performed and pass criteria listed herein.

A. Hydrostatic Pressure Test **PASS**

Three outer containers were individually tested, under a standard temperature of 23°C, for 5 minutes at 15 psig. Each container was sealed per the manufacturer's recommendation (locking ring tightened to a gap of ¼ in. to 3/8 in.). See also MIL-D-6054F, Paragraph 30.1. Each container was filled at least 98% full of water and tested using water pressure to achieve the 15 psig. No leaks were observed.

B. Stacking test. **PASS**

One combination packaging was stacked with 156 lb for 72 hours, under a standard temperature of 23°C. There was no visible damage to the steel drum. No adverse results were noted.

C. Drop test. **PASS**

One combination packaging (conditioned for a minimum of 24 hours at 18°C (see Part 4. C.)) was dropped 1.2 meters onto the required surface in accordance with Part 4. B., except that the three drops on the chime and the three drops on the locking ring (weakest part of the drum not previously tested) were made on the one packaging. Testing was performed under a standard temperature of 23°C. There was no damage to the 1-quart bottles, nor any leakage evident. Except for minor denting of the impacted area, no adverse results were noted.

D. Vibration test. **PASS**

One combination packaging was tested on an electro-dynamic vibration table (set at 1-inch vertical double amplitude (peak-to-peak) displacement) at a frequency such that the box was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At the proper frequency the feeler gage could be passed between the bottom of the package and the table surface. Test duration was 3 hours, under a standard temperature of 23°C. There was no damage to the drum or internal containers or any leakage. No adverse results were noted.

Part 8. Marking on Container:

The container specified herein passes the DOT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers may also qualify for the following marking as directed by DoD policy documents.

UN 1A2/Y 9/S/00
USA/DOD

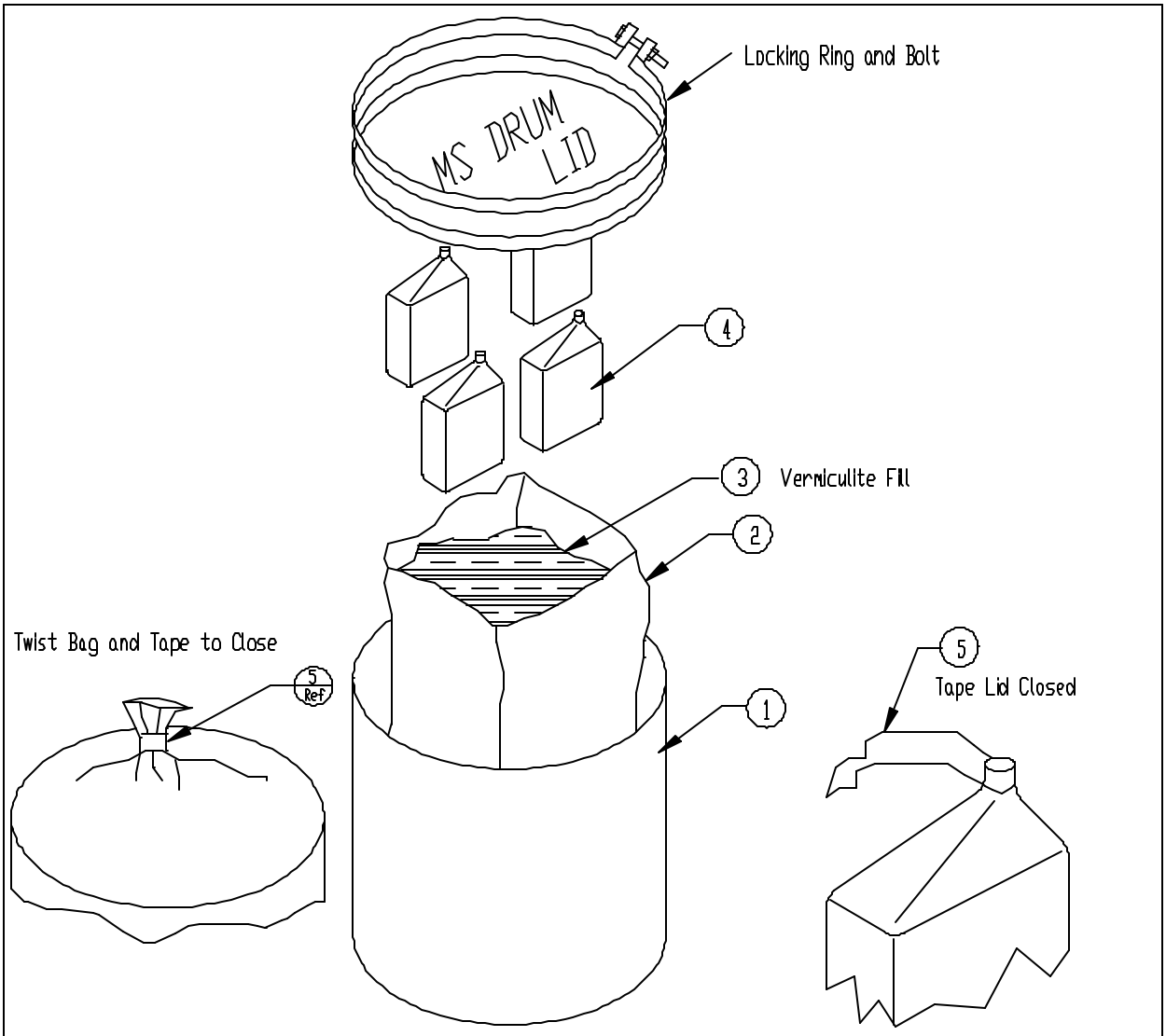
Part 9. References

A. 49CFR 170-180
B. DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
C. ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
D. ASTM D999 - Methods for Vibration Testing of Shipping Containers.

Part 10. Distribution List

Commander
DDC-TO
Attn: Linda McCarthy
2001 Mission Drive
New Cumberland PA 17070

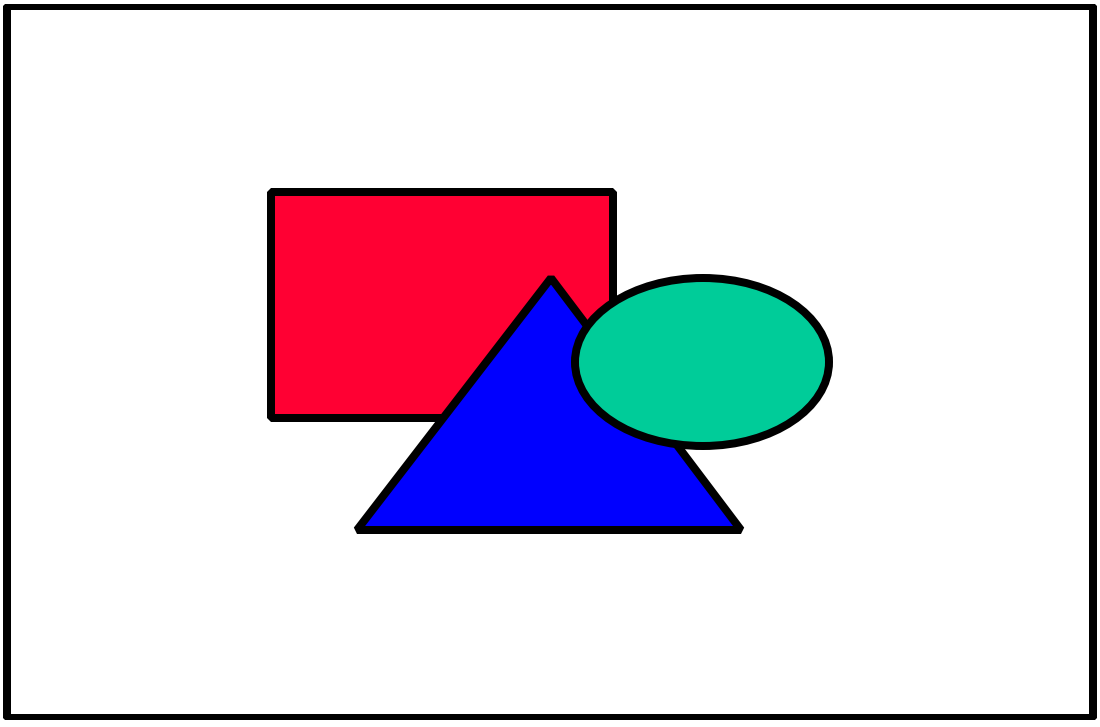
AFMC LSO/LOP
Project Folder



8			
7			
6			
5	A/R	Fiber Tape	
4	4	Inner Container, 1 Quart	
3	A/R	Vermiculite	
2	1	Poly Bag	
1	1	Steel Open Head Drum	
Item	Qty	Description	Notes

	AFPTEF Air Force Packaging Technology and Engineering Facility	Note: Follow All Instructions in TR
File: TR00012D.DWG		Dimensions in Inches
Dwg No: TR00012D		Scale: NONE
Engineer: S J Evans	DATE: 19 July 00	PAGE 1 OF 1

Four inner containers (1-quart plastic rectangular bottles), surrounded by vermiculite cushioning/absorbent.



Combination pack with 4-mil polyethylene bag liner, twisted and taped closed.